Fig. 1: Encoder Block Diagram

Fig. 2: Memory Map : Encoder

Identification N₀ (Key) ~ 50
Cold Boot Counter (CBC) ~ 46
Serial N° (SNR) ~ 52
Conf. Word (CW) ~ 54
Seed ~ 56
User Derived Key Information ~ 58
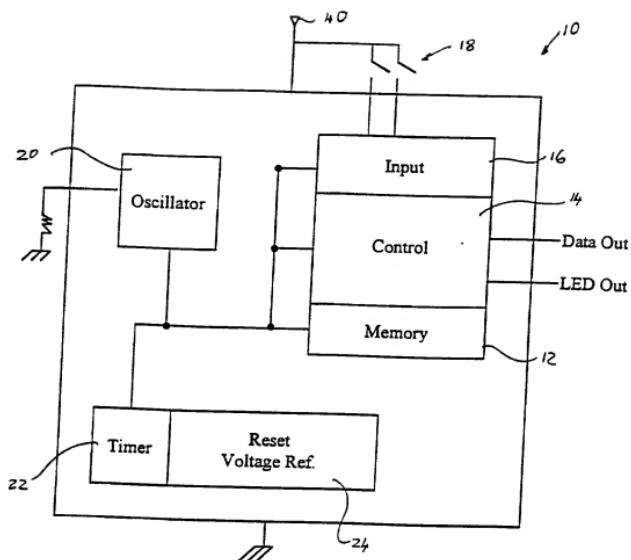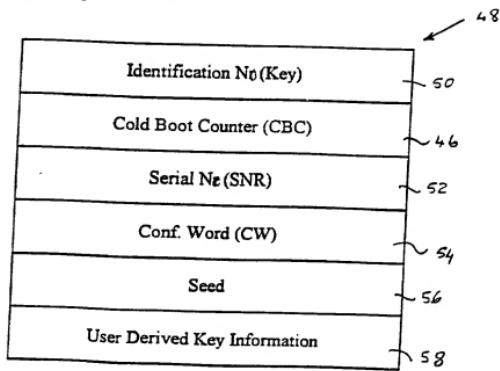
Fig. 3: Decoder : Block Diagram *84* *80*

XTal	Oscillator	Timer
Data in	Control Unit	Decoding & Key Gen Algorithm
Learn		Memory
	Output	Reset & Voltage Ref

102
98
100
82
94
96
86
88
90
92
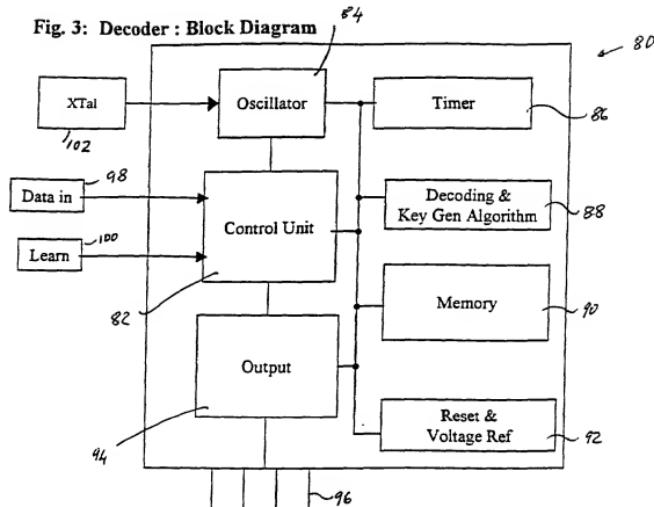
Fig. 4: Decoder Memory Map: Non-volatile memory *104*

Generation Key	*106*
TX_1: CBC, Seed/Serial, User ID N$_0$	*108 (1)*
⋮	
TX_N: CBC, Seed/Serial, User ID N$_t$	*108 (N)*
Config Word	
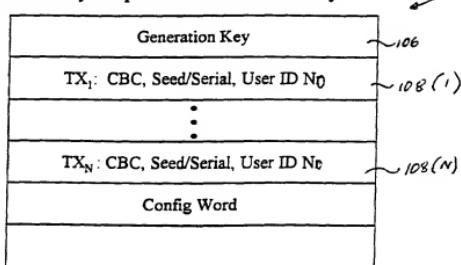
Fig 4 a

Decoder: Volatile Memory Map

| TX_1: Timer Value |
| ⋮ |
| TX_N: Timer Value |
| Keys |

Fig. 5: Data Word

Timer	Command	Portion of Serial Number	Fixed Code or User Derived Information	Utility *

30   32   34   36   38   28
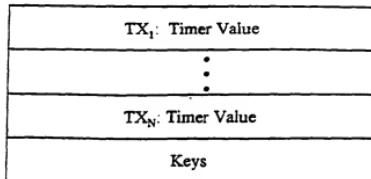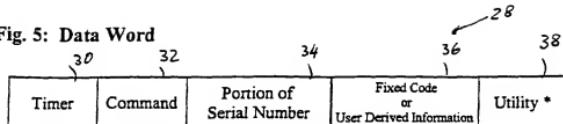
* repeat, battery level, shift levels

Fig. 6: Transmission Word

CRC	CBC+	Command *	Encrypted Data Word	Serial Number	Header

46   72   74   34   74   70   78
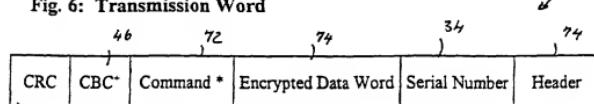
* Info - repeat, battery level, shift levels
+ Only a portion need be sent with every transmission word

Fig. 7: Memory locations for learning encoders.

1
2
•
•
•
n-1
n

◄———— First Encoder Data
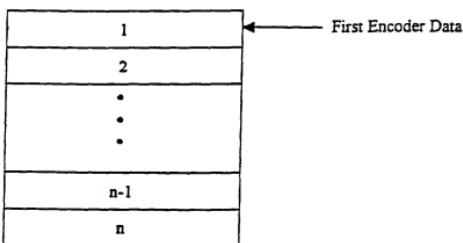
Fig. 8: Learning a second encoder

Second Encoder Data ———►

1
2
•
•
n-1
n

First Encoder Data

Fig. 9a : Encoder: Normal operation Part I

Reset — 210

Increment Cold Boot Counter — 212

218 — Yes

Timer + 1

Inc. Timer? — 216

No

Timer Overflow — No — 220

Inputs Active — 222 — No

Yes

Debounce Read Inputs — 224

Valid Inputs ? — No — 277

Yes

226 — Read Timer Construct Data Word — 228

230

HST* running ? — No — 232

Start HST

Yes — 234

Encrypt Data Word
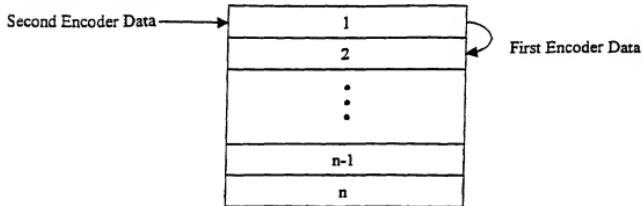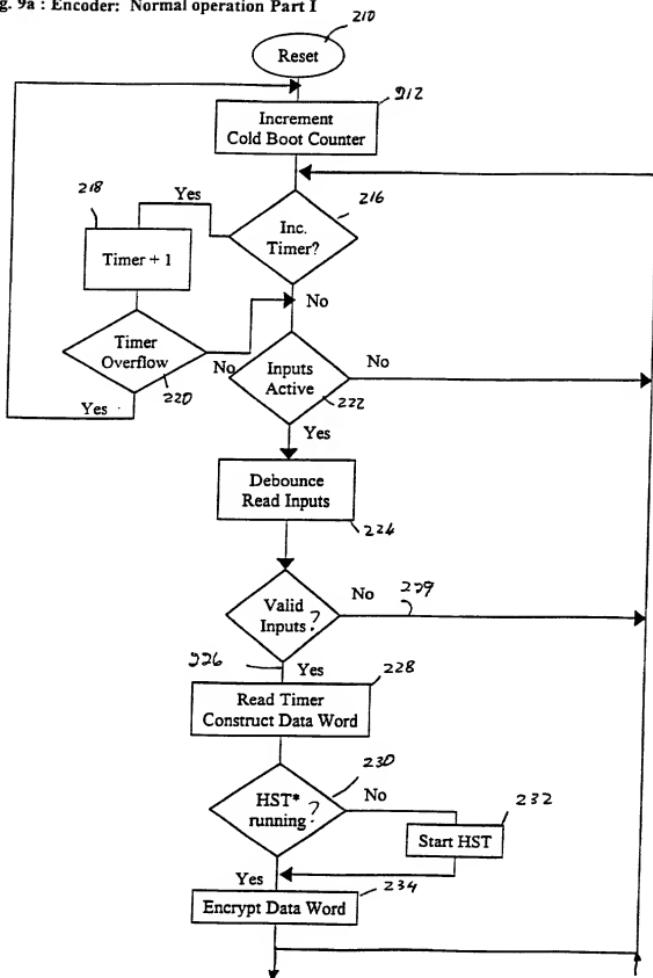
* High Speed Timer

Fig. 9b: Encoder: Normal operation Part II
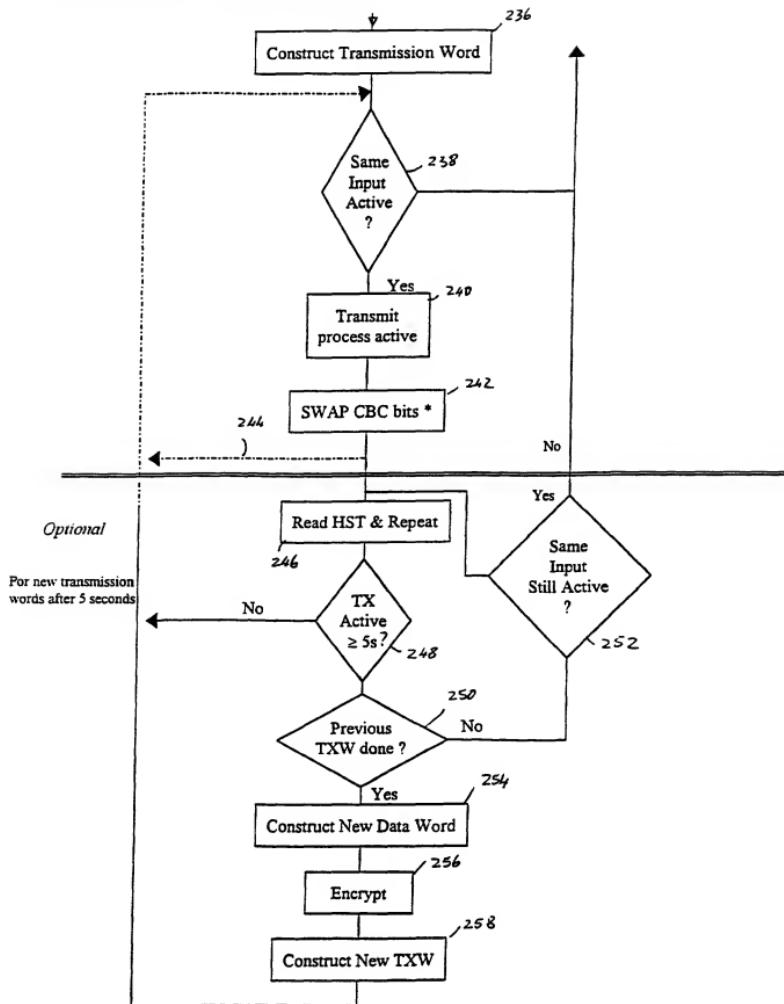
* with every word in a transmission that consists of a string of words, the CBC is partially transmitted

Fig. 10a : Encrypt

```
                    ┌─────────────────┐
                    │     Start       │ ── 300
                    └─────────────────┘
                             │
                                                    302
                    ┌─────────────────┐
                    │   Get Command   │
                    │   Get Key & CBC │
                    └─────────────────┘
                             │
                                                    304
                    ┌─────────────────┐
                    │   Get Data Word        │
                    │ Get User Derived Info  │
                    └─────────────────┘
                             │
                                                    306
                    ┌──────────────────────┐
                    │   Encrypt Data Word       │
                    │   & User Derived Info     │
                    │ Using Algorithm + Key + CBC│
                    └──────────────────────┘
                             │
                                            308
                    ┌─────────────────┐
                    │     Done        │
                    └─────────────────┘
```

Fig 10b:

```
                        ┌──────────────────┐
                        │    Data Word     │─ 312
                        │ User Derived Info│
                        └──────────────────┘
                                 │
              314                ▼
  ┌─────────────┐         ┌──────────────┐          ┌──────────────────────┐
  │  Key & CBC  │────────▶│   Encoding   │─────────▶│  Scrambled Data Word │  74
  └─────────────┘         │   Algorithm  │          └──────────────────────┘
                          └──────────────┘
                                 310
```
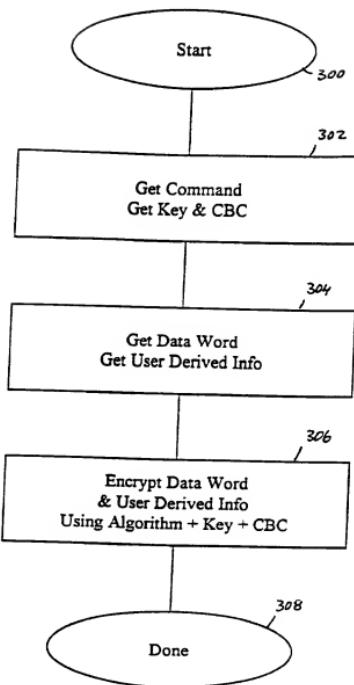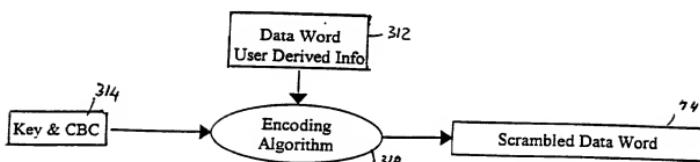
Fig. 11: Decoder : Normal Operation

Reset — 350

Scan Input
352

Valid RX Format — 354 → No

Yes — 356

Check CRC
Check Serial No?
Check CBC portion

Match Serial N? — 358 → No

Yes

Match CBC? — 360 → No

Receive More Data
Make up new CBC — 362

Yes

Read Td — 364

Calculate Dec Key — 366

Perform Decryption — 368

User Derived Info Match? — 370 → No

Yes

$Td \leq Te \leq Td + Wa$ — 372

$Td + Wa \leq Te \leq Td + Wr$ — 378 → No

Yes — 380

Create a Re-calibrated Tr'
Receive a next code
from next activation and decrypt — 382

$Td \leq Te \leq Td + Wa$ — 384

No

Interpret Commands
Activate Outputs — 390

$TR = Tr'$ — 386 — Yes

Yes — 374

Interpret Command
Activate Output

Re-calibrate Tr — 376

Cancel Tr'

Fig. 12: Learn Operation: Decoder


```
                      ( Learn        )  ← 400
                      ( Activated    )
                           │
                           ▼
                    ┌──────────────┐  ← 402
      ┌────────────►│   Debounce   │
      │             └──────────────┘
      │                    │
      │                    ▼
      │              ╱ Learn  ╲          No
      │             ╱ Selected ╲────────────────┐
      │             ╲    ?     ╱                 │
      │              ╲  404   ╱         ┌─────────────────┐
      │               ╲─────╱           │ Normal Operation │
      │                  │ Yes          └─────────────────┘
      │                  ▼        ← 406
      │          ┌──────────────┐
      │          │ Receive Rx words │
      │          │   (several)      │
      │          └──────────────┘
      │                  │
      │   408            ▼
      │     No    ╱ Correctly ╲
      ◄──────────╱  Completed  ╲
      │          ╲            ╱
      │           ╲──────────╱
      │      410      │ Yes        ← 412
      │          ┌──────────────┐
      │          │  Read Td     │
      │          │ Construct CBC * │
      │          └──────────────┘
      │                  │
      │                  ▼
      │          ┌──────────────┐
      │          │ Calculate Key Value │
      │          │   Decrypt    │
      │          └──────────────┘
      │                  │  ← 414
      │                  ▼        ← 416
      │  ┌────────────────────────────────────┐
      │  │ From decrypted data word determine  Tr │
      │  │ User Derived Info and store in non-volatile memory │
      │  └────────────────────────────────────┘
      │                  │
      │                  ▼        ← 418
      │          ┌──────────────┐
      │          │ Indicate Learn Status │
      │          │ on LED or other display │
      │          └──────────────┘
      │                  │
      └──────────────────┘
```
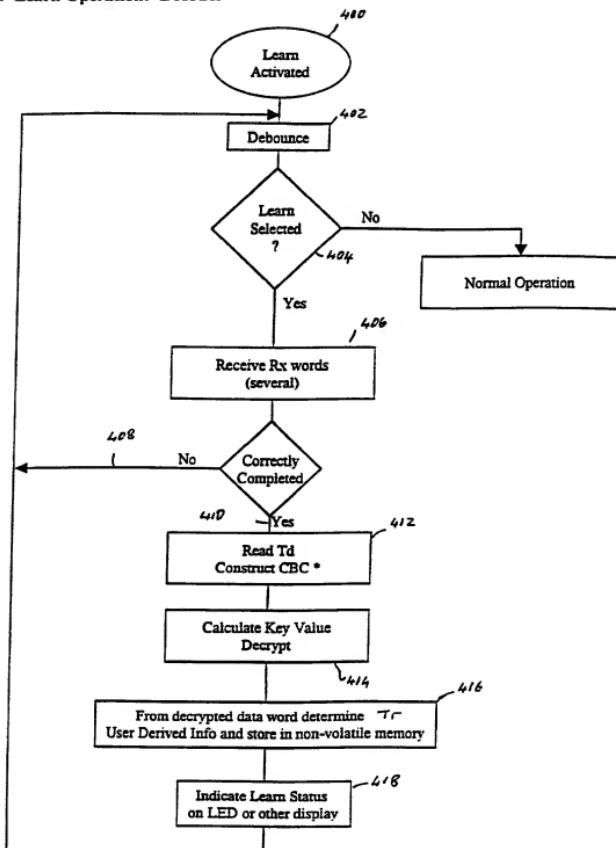
* Cold Boot Counter

Fig. 13: Encoder: Setting User Derived Information

Power-up — 450

Special Inputs Activated* ? — 452
Yes — 456
No

Activate HST (at random position) — 458

Normal operation — 454

Same Inputs Active* ? — 460
Yes
No

Store in NVM** — 466

Read HST — 462

Construct User Derived Info Word — 464
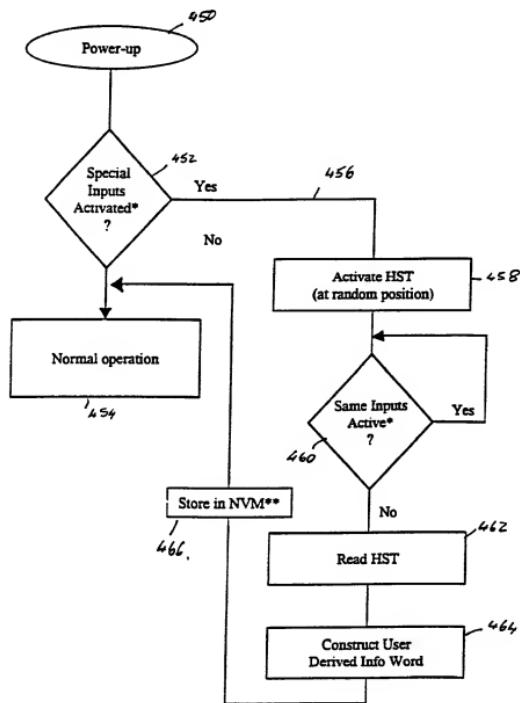
* To activate setting of User Derived Information
** NVM - Non-volatile Memory